Charge Writing on PMMA by AFM – a Path to ‘Guided’ Assembly of Nanostructures

F. T. Xu and J. A. Barnard

MINT Center, The University of Alabama and
Department of Materials Science & Engineering, University of Pittsburgh

This project was funded by NSF-DMR 0213985.

Abstract

Unique opportunities exist for utilizing nanoscale charge patterning for directed electrostatic assembly of complex functional nanostructures from discrete charged/polarized nanoparticles (e.g., colloidal spheres) or macromolecules. Such nanostructures can be designed to enable new types of sensing and actuation, to display novel optical and tribological properties, to provide selective molecular ‘docking’, nanomechanical motion, etc. In this study we take the first steps in demonstrating electrostatically-templated assembly of nanostructures by exploring the charge storage characteristics of thin PMMA films on Si substrates using AFM-based charge writing and Surface Potential mapping.

Experimental Details

Samples: Poly(methyl methacrylate) (PMMA) spin-coated films on n-type Si(111)
Tests: Charge writing/reading by AFM in contact and surface potential mode
Mica substrate was also used as a comparison to the Si substrate

• Si and Mica substrates yield different charging characteristics in the PMMA (charging for 10s)

The bright and dark dots were created by applying +12 V and – 12 V to the AFM tip when it is in contact with the grounded PMMA/Si(111) films for 10 s

The topography didn’t interfere with surface potential during the charge
• The full width half maximum (FWHM) of the charged dots (positive) were less than 200 nm
• Image width was 10 micrometers.

The decay of four differently charged dots
• Both the positive and negative dots exhibit significant charge dissipation over a period of hours although storage is still evident for a few days. The time scales are appropriate for guided assembly processes.
• The FWHM remains about same with time

Conclusion

We have demonstrated the viability of using PMMA as a charge storage medium which may be used to guide the assembly of charged molecules and nanoparticles. The next phase of the work will involve exposing the patterns to solutions containing charged objects.

For more information and reprints contact:
Fengting (Frank) Xu
E-mail: fex1@pitt.edu